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ABSTRACT

The study investigated the use of phonological encoding and chunking strategies (the skimming and clustering of highly familiar material into meaningful units) with congenitally deaf students at the middle and upper levels of an oralist school as well as hearing students at the second, third, fourth, fifth, and college grade levels. Ss were asked to identify all instances of a particular letter in three passages presented in either normal prose, scrambled words, or scrambled letters. Results indicated that deaf Ss made fewer errors than did hearing Ss (suggesting less efficient reading by deaf Ss), and that both hearing and deaf Ss showed evidence for phonological encoding. A replication of the study with congenitally deaf children from a total communicaton program found equal evidence for speech recoding with no difference in comparison to the deaf children trained under the oral approach. Results demonstrated that the deaf child's difficulties with reading cannot be attributed to a reliance on an inefficient visual (rather than phonological) coding strategy. (DB)

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The Development of Reading Skills in the Congenitally Deaf[1]

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It has been known for some time now that congenitally deaf children exhibit great difficulty in attaining a reading level beyond that of the fourth-grade hearing child (Conrad, 1977a; Furth, 1966; Trybus and Karchmer, 1977). Unfortunately, while there has been considerable progress in evaluating the syntactic factors contributing to this problem, there has been relatively little research examining the nature of the information-processing strategies used by these children. Over the years, research with hearing children has pointed to the importance of two particular skills in reading: "phonological encoding" and "chunking." "Phonological encoding", or speech recoding, refers to the process by which a child converts printed text to some acoustic form prior to deriving mearning. This mediation process is believed to facilitate the retention of information in short-term memory (Conrad, 1972b; Crowder, 1972; Rozin and Gleitman, 1977). "Chunking" refers to the ability to group elementary units of text, e.g., individual features, letters and words, into higher constituents (like phrases) in order to conserve processing resources and thus read more efficiently. As a child becomes older and more experienced with

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reading, he becomes better able to use the redundancy and syntactic constraints of the English language in order to increase the size of the unit of reading (Friedrich, Schadler and Juola, 1979; Samuels, La Berge and Bremer, 1975), and to anticipate the meaning in text (see Adams, 1977; Gibson and Levin, 1975; Levin and Kaplan, 1970). The significance of these two skills in hearing readers is witnessed in the fact that good readers can be differentiated from poor readers by the extent to which they mediate print with speech (Liberman, Shankweiler, Liberman, Fowler and Fischer, 1977; Mark, Shankweiler, Liberman and Fowler, 1977) and by the extent to which they use a selective chunking strategy (Weaver, 1978).

If speech recoding and chunking are strategies which are central to the reading process, then one might predict difficulty in reading when these processing mechanisms are hindered, as in the case of the congenitally deaf child. If acoustic experience is necessary for the normal development of speech recoding, then the performance of the deaf child should reflect an inability to appreciate the relationship between spoken and written English. In fact, several investigators have argued that the deaf child's inability to access some verbal code forces him to rely on a relatively inefficient visual code in reading and in memory (Conrad, 1972b; Mac Dougall, 1979). According to this hypothesis, deaf children show such difficulty in reading because of this reliance on visual representation. It was the purpose of the present study to trace the development of these

speech recoding and chunking skills in deaf children, as well as to determine what role, if any, these strategies play in their reading performance.

The present study used a visual detection task as a means of tracing the development of phonological encoding and chunking. In this task, subjects are asked to read through a passage and to search for all instances of a particular target letter. In visual detection tasks, normal hearing readers will fail to detect letters which are not pronounced within a word. For example, if asked to detect the letter 'g' in a passage, they will tend to miss the letter if it appears in the word 'light' as opposed to the case when it appears in the word 'large'. This failure to detect unpronounced letters has been used as evidence for the use of phonological coding in hearing readers (Corcoran, 1966; Doehring, 1976; Healy, 1976; Mohan, 1978).

It has also been noted that normal hearing readers will typically not process every letter or word of text, but rather will skim over highly familiar material and "chunk" that material into units. For example, when asked to search for the letter 'e' in a detection task, readers typically fail to detect the letter if it occurs in a highly familiar word like "the" (Drewnowski, 1978; Drewnowski and Healy, 1977; Healy, 1976, 1980). This type of result has been used as evidence for the use of chunking strategies by hearing readers.

In the present experiment, three types of passages were used, following Drewnowski (1978), as a means of evaluating the use of chunking strategies by children at various ages. Refer to Appendix. Each passage was 293 words

in length. The first passage was normal prose (NP), a story describing a simple event. The second, the scrambled-word (SW) passage, was comprised of the same words used in the prose passage, but these words appeared in random order. Those words which contained the target letter, however, appeared in the same position in the SW passage as they did in the NP passage. The final passage was comprised of scrambled letters (SL), again with the constraint that the target letter itself appeared in the same position as it did in the other two passages. By manipulating the text structure in this way, it was possible to restrict the level at which the reader was able to process the passage. Thus, while the NP passage permitted the reader to use syntactic and semantic cues to facilitate his reading, the other two passages were more restrictive. In the SW passage, subjects could use the orthographic redundancy of English and process the text at the word level. In the SL passage, of course, subjects were restricted to the single letter level of processing.

Because position of the target letter was invariant across the three passages, detection performance should be affected only by the structure of the text and by the reader's cognitive abilities. By examining the relative number of detection errors made on the three passages, it is possible to estimate the level at which a subject is processing text.

Within the context of the visual detection paradigm, phonological coding is measured by the extent of the difference in errors made on the "pronounced" and "unpronounced" instances of the target letter. The presence

of chunking is measured by the relative number of errors made on the various passages (see Drewnowski, 1978). If the deaf reader uses the same processing mechanisms as the hearing reader, one would expect an increase in both phonological coding (Conrad, 1971, 1972b) and chunking (Condry, Mc Mahon-Rideout and Levy, 1979; Drewnowski, 1978) with age. On the other hand, if these subjects do not have access to phonological information (Locke, 1978; Mac Dougall, 1979), then there should be no difference in errors between the pronounced and unpronounced words. If these deaf subjects are relying solely on a visual strategy and do not have higher-level chunking skills available, one would expect no difference in number of errors between the three types of passages.

Subjects in the study included second, third, fourth, fifth graders and college students of normal hearing, as well as two groups of congenitally deaf students with a severe to profound hearing loss (> 71-dB in better ear). These two deaf groups represented the middle and upper levels of an oralist school, i.e. children trained with an emphasis on speech and lipreading. All subjects were given a booklet which contained the three passages, as well as a page with two questions which tested comprehension of the story (NP). Subjects performed the task at their own pace. Only those subjects who correctly answered both comprehension questions were included in the data analysis.

RESULTS

An analysis of reading rates and errors revealed some evidence of a speed-accuracy tradeoff.[2] The analysis of variance performed on the data revealed some rather surprising results. First of all, the deaf subjects as a whole made fewer errors overall than did the hearing subjects--a result which suggests that the deaf were perhaps reading less efficiently than were the hearing. That is, their detection performance was not as affected as was that of the hearing children by semantic and syntactic context. Moreover, all groups--hearing and deaf alike--showed evidence for phonological encoding (see Figure 1). That is, all subjects tended to miss more frequently those letters which were not pronounced (nonmodal) relative to those which were pronounced (modal) within a word. While this "pronounceability effect" was significantly greater in the hearing children, the deaf children also showed this effect. Thus it seems that even deaf readers have some access to phonological rules and in fact use such rules in reading. Despite these similarities, however, the two groups also showed interesting differences in performance. Unlike the deaf children, the hearing children tended to have great difficulty with the SL passage (see Figure 2). The second graders in particular tended to make the greatest number of errors on this passage relative to the others. On the other hand, Figure 3 reveals that both the deaf children and hearing adults made more errors on the NP and SW passages relative to the SL passage. This result suggests that these two subject groups were sensitive to the differences in contextual constraint which characterized the various passages. More specifically, it suggests that these readers were processing the text at least at the level of the whole word, rather than on a letter-by-letter basis.

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[2]Significant negative correlations were found in the data of the third and fourth graders on the NP passage, in that of the upper school deaf on the SW passage and in the fifth graders' data on the SL passage.

Another interesting result focuses on the pattern of errors made on the various types of grammatical class (Figure 4). Both the hearing children and the upper school deaf children made significantly more errors when the target letter appeared with an adjective relative to its appearance in other classes of words. This result suggests that both groups were focussing their attention on the nouns, verbs and functors and giving little attention to adjectives. Psycholinguistic research has shown that nouns and verbs tend to be the most informative parts of a sentence (Clark and Clark, 1977). Thus the present results are consistent with the use of this psycholinguistic strategy. However, it is not clear why functors show such a low error rate.

Taken together, these results suggest that these orally trained deaf children are using reading strategies (speech recoding, chunking, psycholinguistic proceses) which are quite similar to those used by normal hearing readers. In an effort to determine whether the incidence of speech recoding exhibited by the deaf children here could be attributed to the emphasis on speech skills which they receive as part of their oralist training, a second group of congenitally deaf children was tested--this group being from a Total Communication (TC) program which uses sign language as the major form of communication in training. The TC children were matched with the oralist children with regards to mean hearing loss, age, reading level and speech intelligibility (Figure 1). The data analysis of the performance of the TC children on the same detection task revealed evidence for speech recoding as well, with no difference in comparison to the oral children. Thus it seems that the incidence of phonological encoding cannot be attributed merely to type of training.

The present results are significant for several reasons. Perhaps most importantly, they demonstrate that the deaf child's difficulties with reading cannot be attributed to a reliance on an inefficient visual coding

strategy, as has been suggested by several previous investigators. More specifically, these results suggest that the congenitally deaf and the hearing reader use strategies which are actually quite similar. They both tend to transform the printed text into acoustic form while reading. Moreover, they both tend to apply the same type of psycholinguistic rules in deciding what parts of a sentence are most informative and thus require the most attention.

A crucial issue remains unresolved, however. That is, how does the congenitally deaf child, who presumably has had only limited acoustic experience, acquire a set of phonological rules which he can use for recoding print? Dodd (1976) has found that the articulation errors of profoundly congenitally deaf children indicate adherence to the same phonological rules used by normal hearing children. Moreover, the source of such phonological information appears to be lipreading. However, the information provided by lipreading is necessarily limited and future research on this question is required.

Regardless of the still uncertain nature of the phonological issue, the present study was valuable in its attempt to examine the use of particular information processing strategies by the deaf. This effort stands in contrast to the majority of research in the field of deaf education which has tended to focus predominantly on linguistic deficiencies per se. The present results have relevance for reading in normal hearing children as well, suggesting that the sound-letter correspondence rules so important in early reading are not in fact dependent on acoustic information for their acquisition.

APPENDIX

Reading Skills - Deaf

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NORMAL PROSE PASSAGE

The young girl Nancy ran into the garden. Her cat was running away from a dog. She sat down and began to cry.

"Please come back! I will give you some milk. Please come back!" Her cat was gone.

SCRAMBLED-WORD PASSAGE

He young girl back have to her garden. She said into running I about him dog. Eat was in yard began this you.

"Said cat was! He spots give water watched with. In about your!" Off was day gone.

SCRAMBLED-LETTER PASSAGE

Yay lrcog ghia trunn enn nedr iah genehc. Oat ttr uaw aarfiag yswm nonr n adg. Son dde nats how pagen my eos.

"Toearl becc iwle! V abiu gyci lok cakm soop. Mlalee ieec kmsb!" Sna ywu etl gdho.

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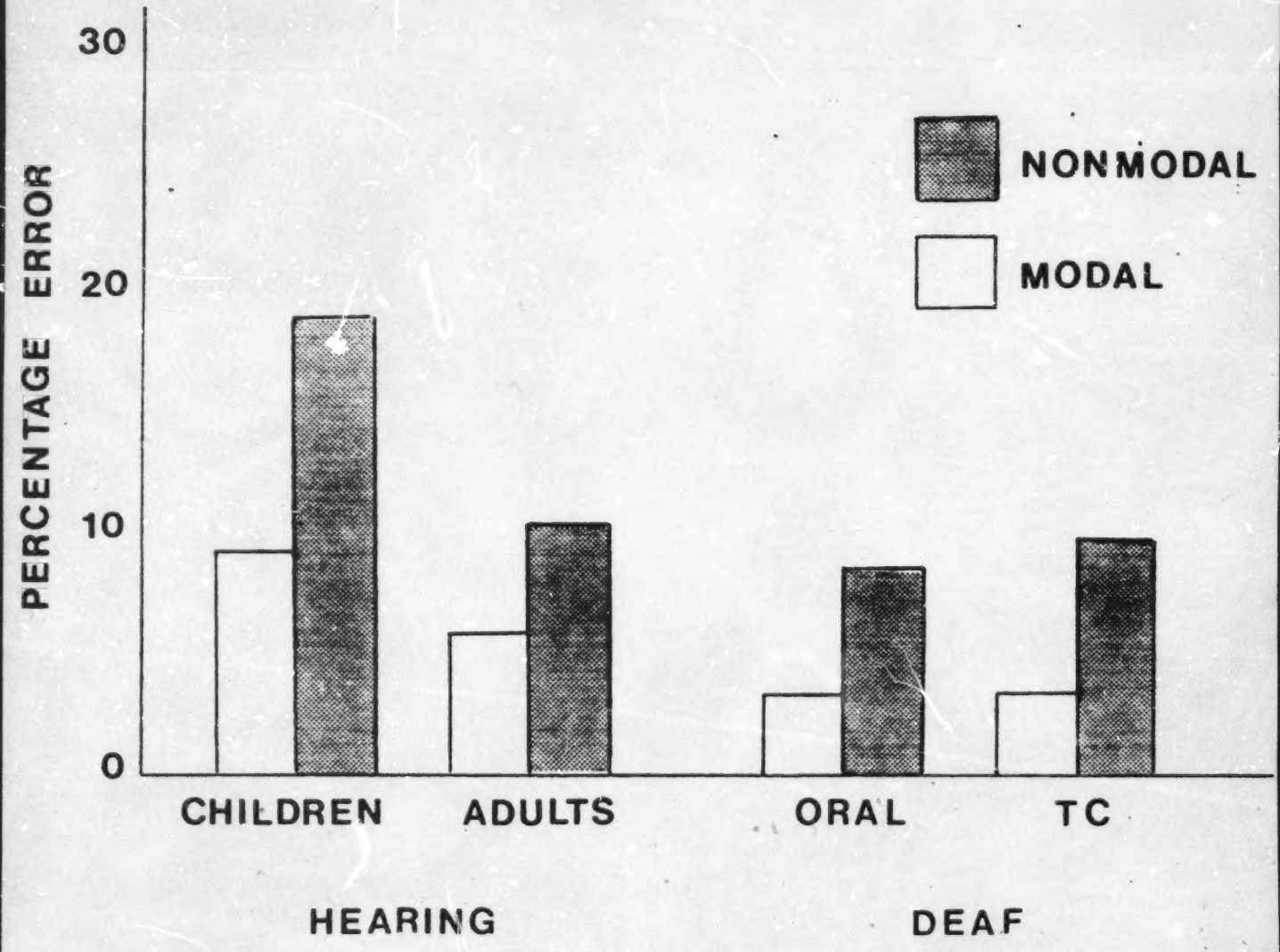
30
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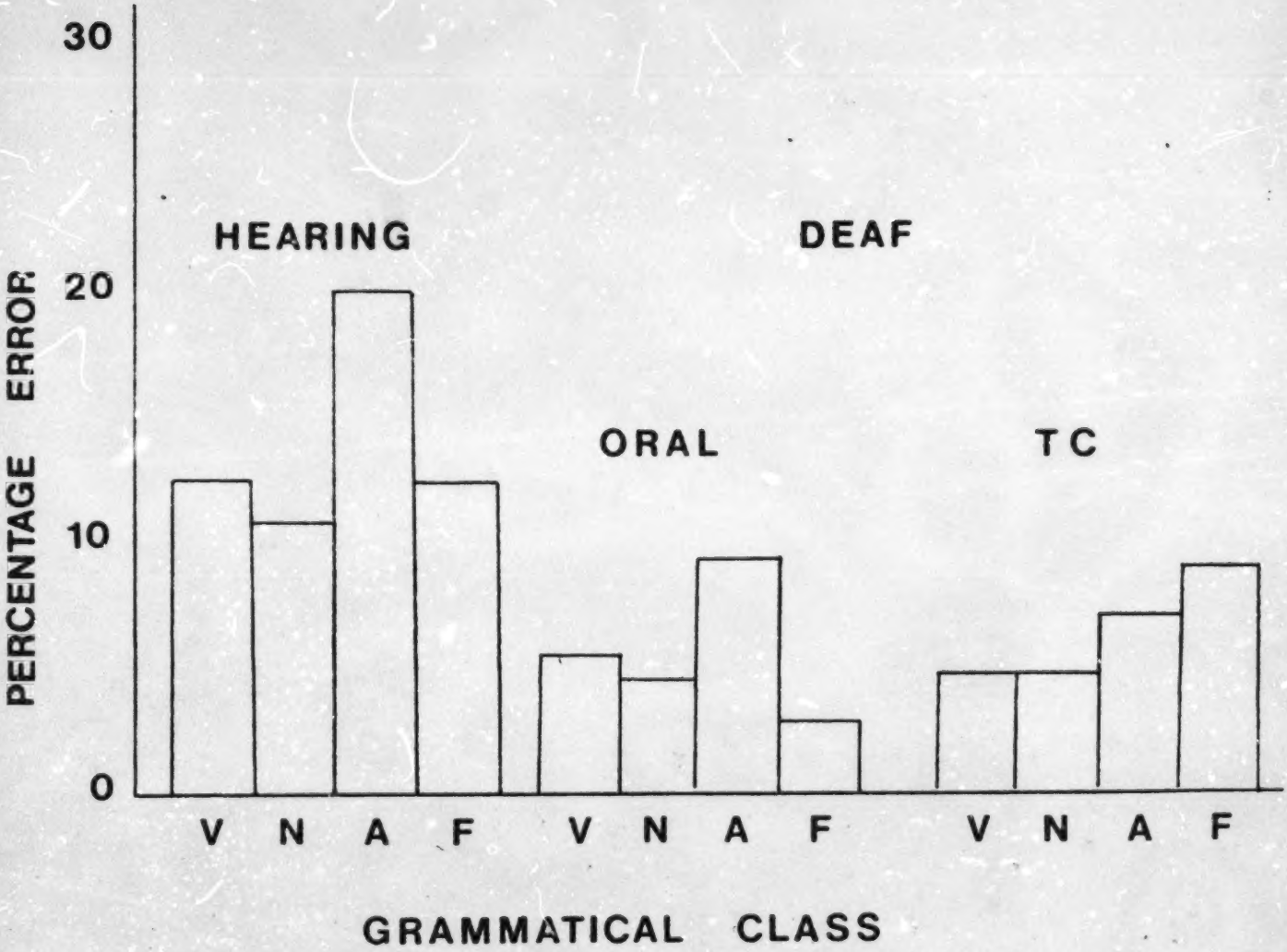
PERCENTAGE ERROR
NONMODAL
MODAL
CHILDREN
ADULTS
ORAL
TC
HEARING
DEAF

Figure 1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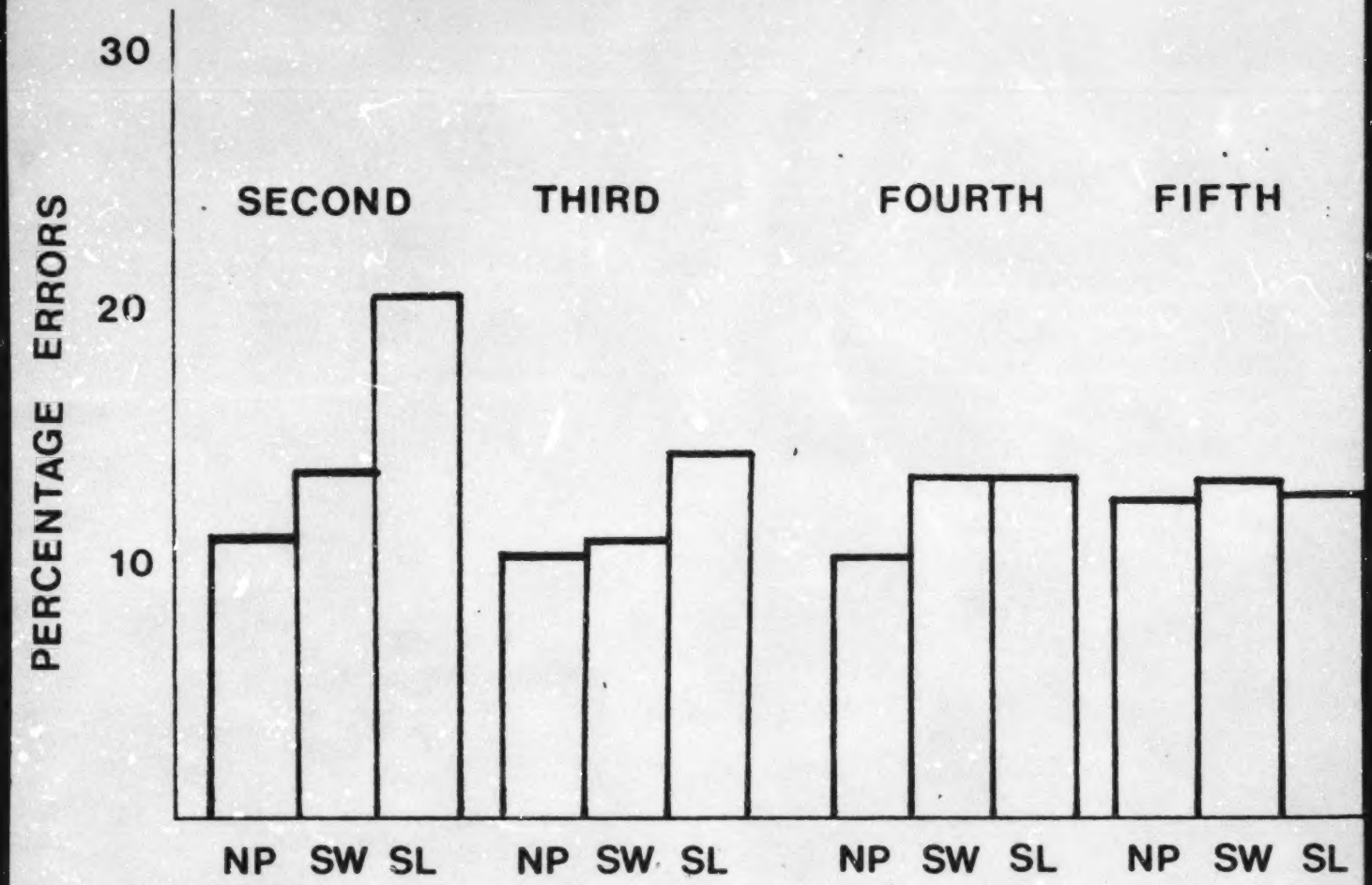
PERCENTAGE ERROR
HEARING
DEAF
ORAL
TC
V N A F V N A F V N A F
GRAMMATICAL CLASS

Figure 2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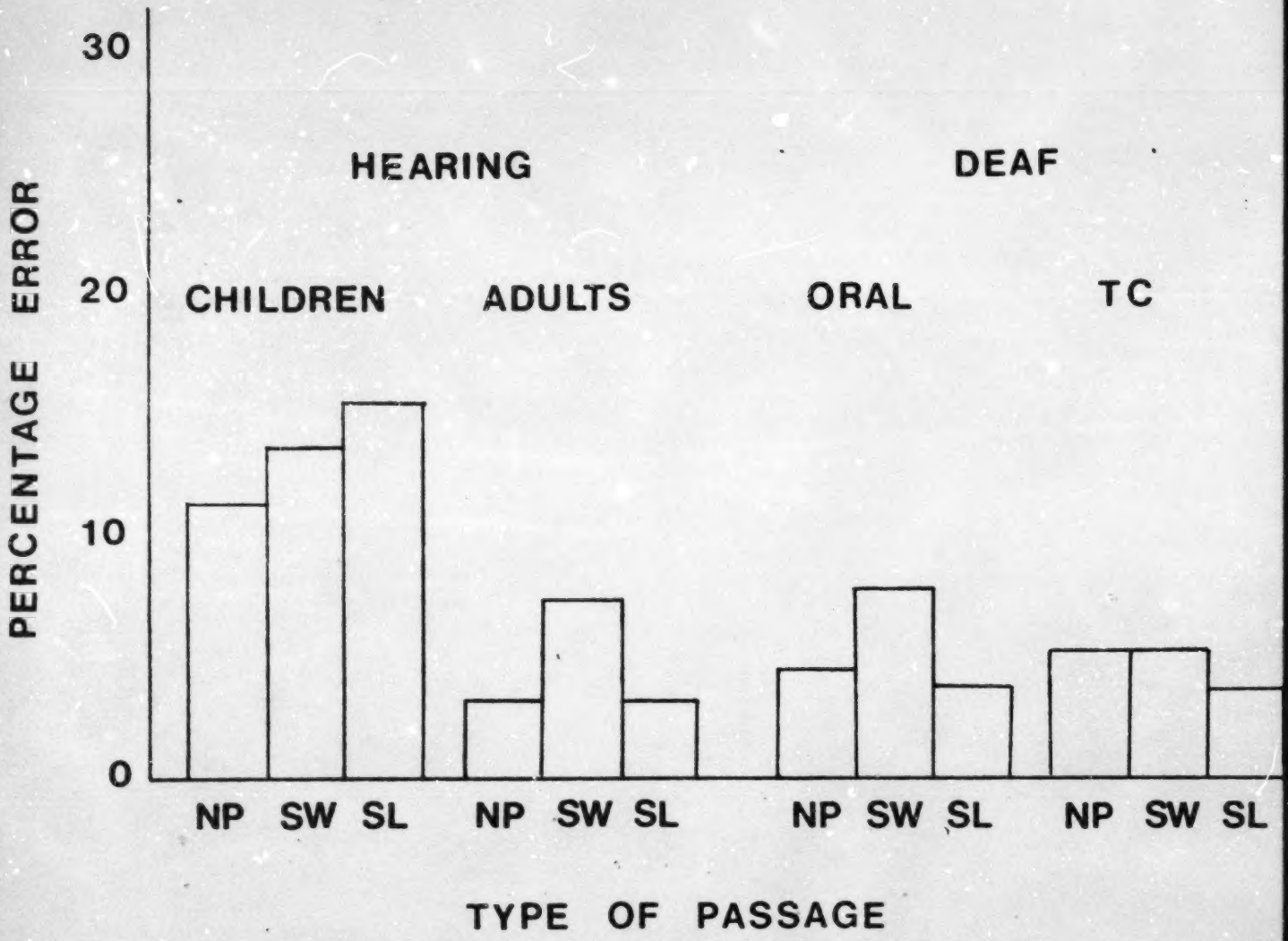
20
10
PERCENTAGE ERRORS
SECOND
THIRD
FOURTH
FIFTH
NP SW SL
NP SW SL
NP SW SL
NP SW SL
TYPE OF PASSAGE

Figure 3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PERCENTAGE ERROR
HEARING
DEAF
CHILDREN
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NP SW SL
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NP SW SL
TYPE OF PASSAGE

Figure 4